ELECTROMAGNETIC COMPATIBILITY AND SAFETY

Master Degree in Communications & Data Security Engineering (ISDC)
Master Degree in Information Technologies Engineering for Communications and Health (ITICS)

EMRS LAB

INTRODUCTION

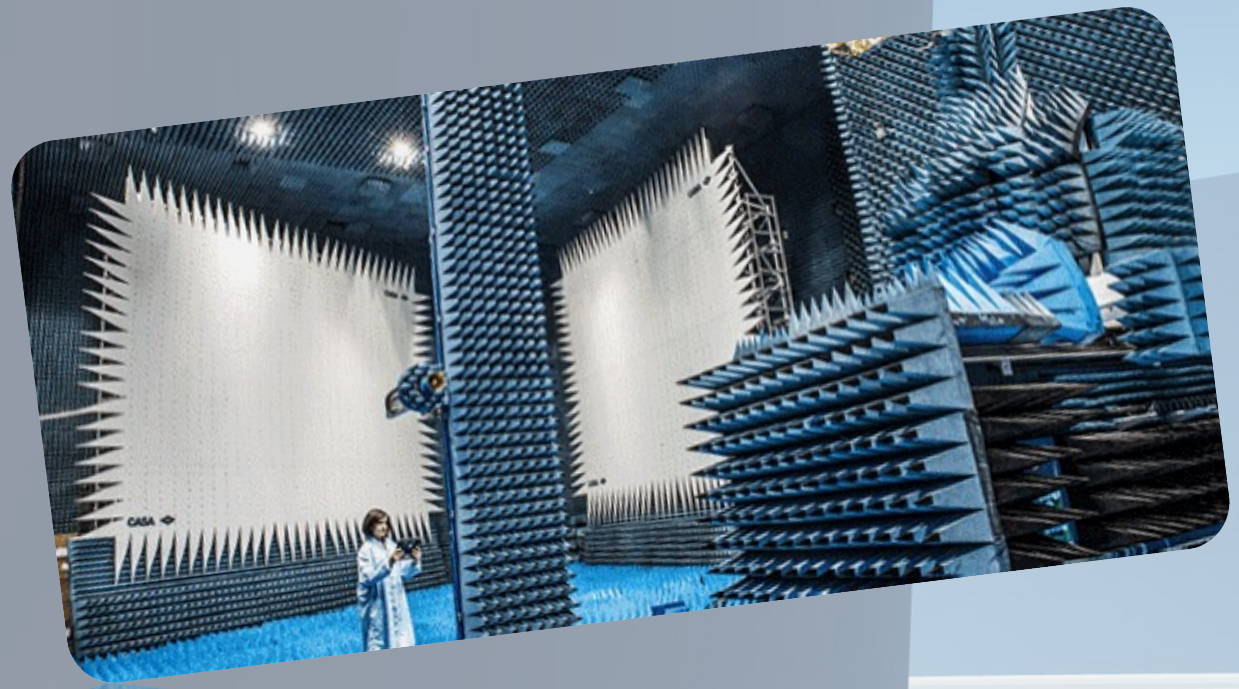
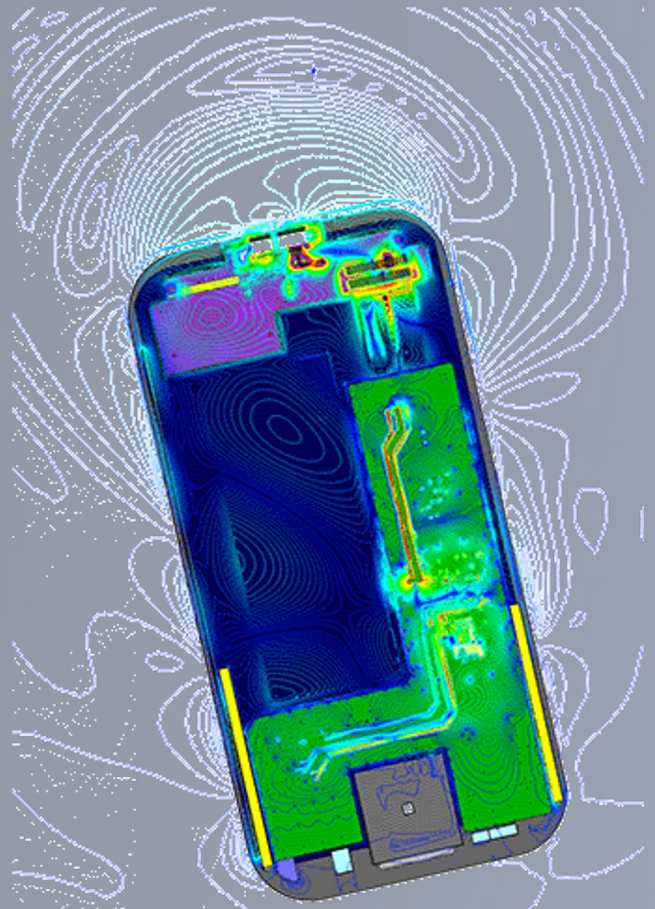


Table of Contents:

- ✓ Overview
- ✓ Organization
- ✓ Audience
- ✓ Basics

INTRODUCTION: OVERVIEW



Electromagnetic Compatibility

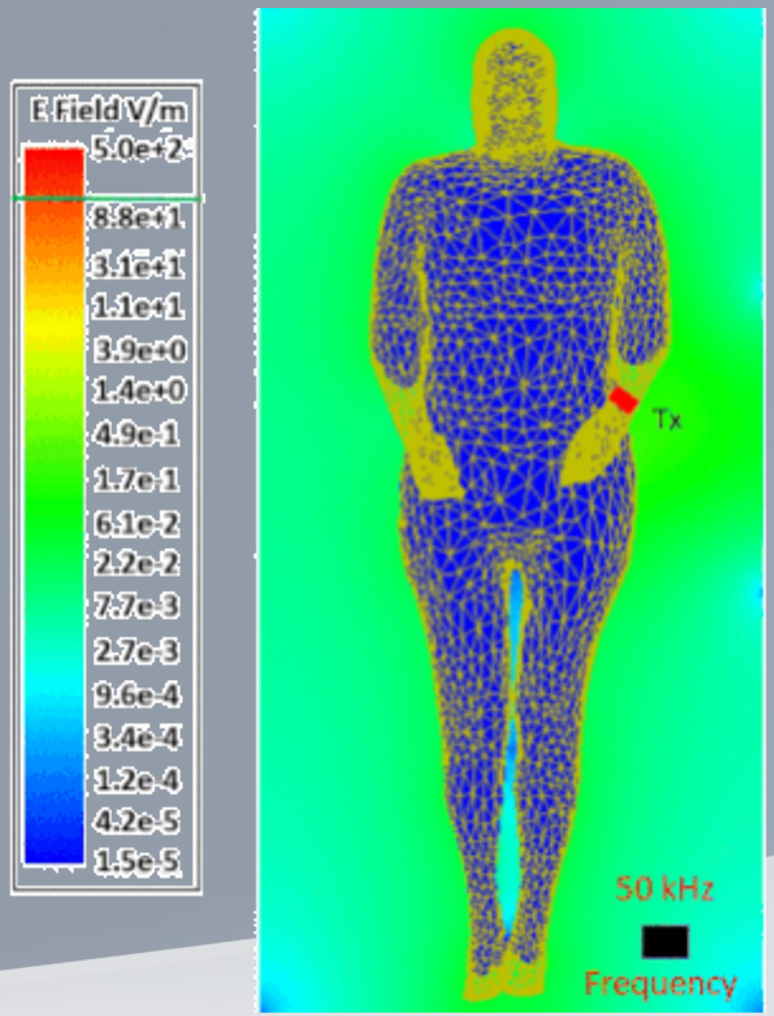
«EMC deals with the study of generation, transmission and reception of ***unintented EM energy*** *with reference to the* ***unwanted effects*** *that it may have with the aim of ensure proper working of the nearby electronic devices operating within the same environment.»*

INTRODUCTION: OVERVIEW

Electromagnetic Security

*«**Security** refers to practices and countermeasures adopted **to prevent intented malicious operations** and **to proctect devices and people** from such events.»*

INTRODUCTION: OVERVIEW



Electromagnetic Safety

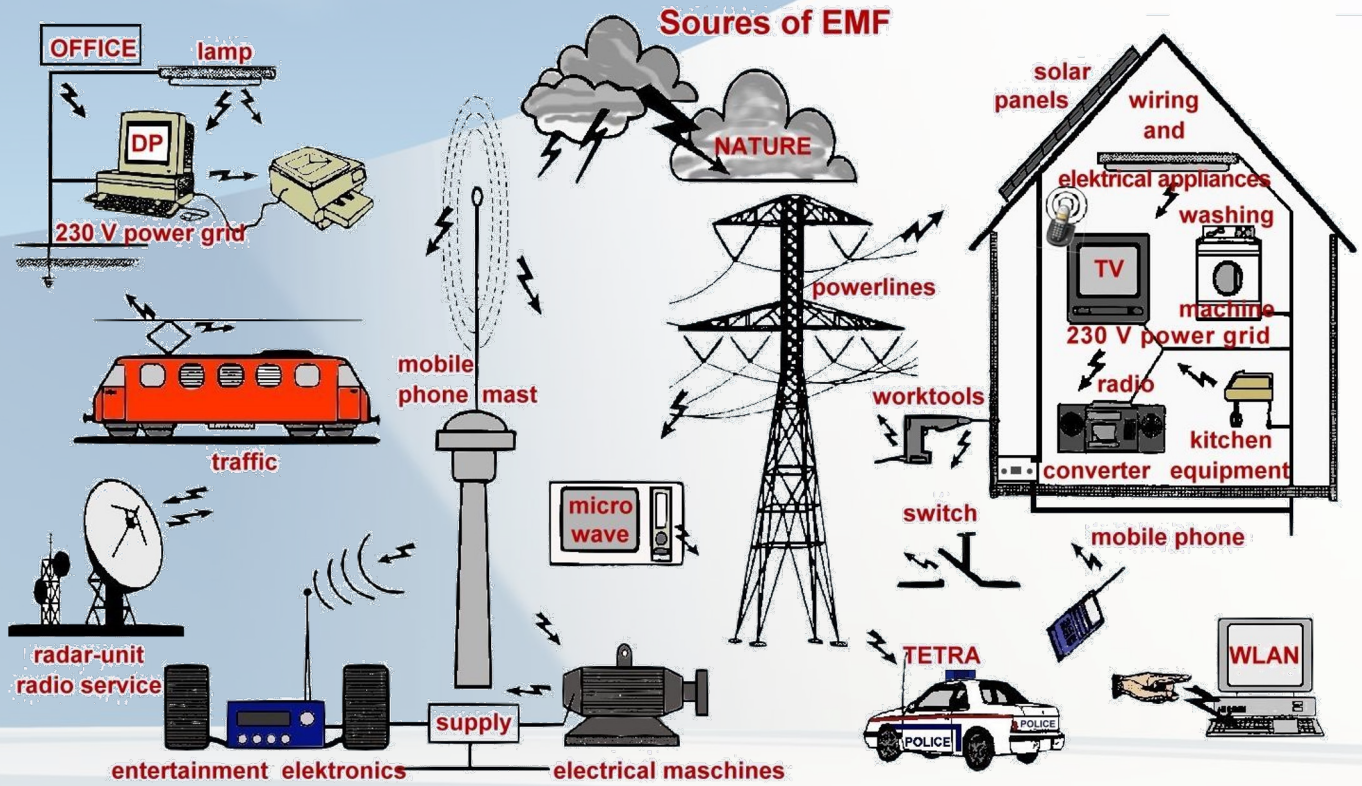
*«**Safety** refers to practices and behaviors adopted **to proctect devices and people** from **unintented events** that may be potentially harmful.»*

INTRODUCTION: OVERVIEW

EMCS: daily life

INTRODUCTION: OVERVIEW

EMCS: daily life



INTRODUCTION: OVERVIEW

EMCS: Stories of failure

1967

The crew of *USS Forrestal* (CVA 59) extinguishes the remaining fires on the flight deck off the coast of Vietnam, 29 July 1967. In the foreground are the remains of an F-4B *Phantom*, behind which can be seen the burned hulk of a second *Phantom*. One hundred thirty-four crew died in this fire, the worst aboard a U.S. Navy aircraft carrier. U.S. Navy photograph.

Phoenix Weather

THE ARIZONA REPUBLIC

Today's Chuckle

Phoenix, Arizona, Sunday, July 30, 1967

Twenty-Five Cents

Forrestal Inferno Claims 46

Find Riot Roots, Commission Told

LBJ Tells SBA To Issue Loans For Riot Repair

Hard GOP Slap at LBJ On Riots Upsets Leaders

Many More Missing; 29 Planes Lost

Guard Is Urged To Retrain Men For Riot Control

Packed Ballroom Honors Hayden, Demo Ex-Chiefs

GOP to Convene In Miami Beach

Features Today

General Interest

Today's Prayer

INTRODUCTION: OVERVIEW

EMCS: Stories of failure

1981

INTRODUCTION: OVERVIEW

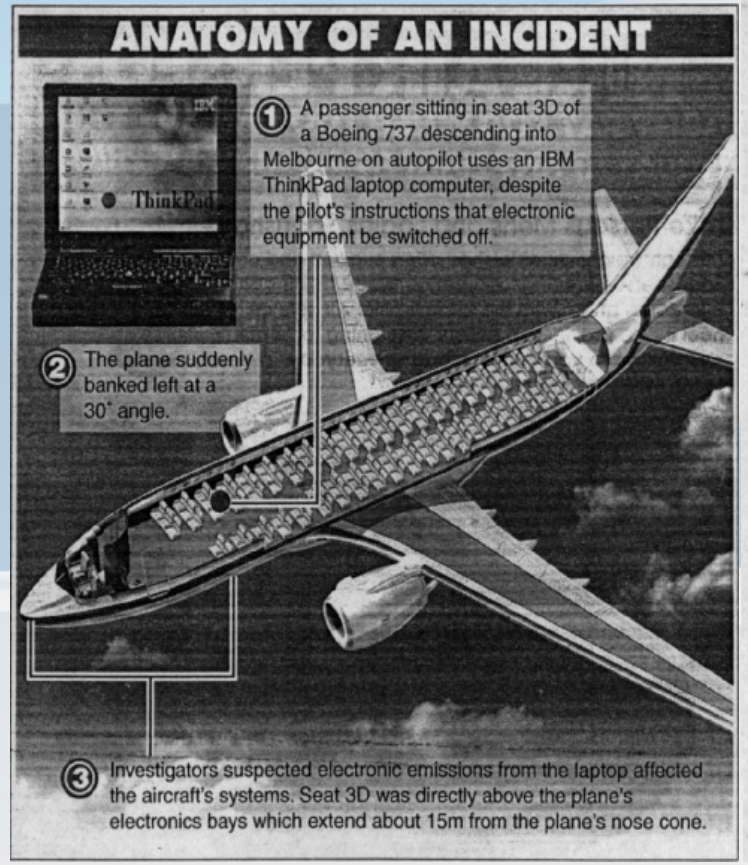
EMCS: Stories of failure

1982

INTRODUCTION: OVERVIEW

EMCS: Stories of failure

1998



THE Boeing 737 was making a normal descent into Melbourne. The plane was on autopilot and the lateral navigation system was working.

In seat 3D, a passenger was hard at work on an IBM Thinkpad laptop computer.

About 60km north of Melbourne the big plane lurched to the left, banking about 30deg.

But no one had touched any of the plane's controls and the movement certainly wasn't part of the autopilot program.

The passenger in 3D may have noticed the movement but remained blissfully unaware of the crisis happening on the other side of the cabin door and equally unaware of what is believed to be his role in it.

"It is suspected that electronic emission from the laptop impinged on the aircraft systems," an air safety report into the incident concluded.

Experts believe that one

By PETER LALOR and ADAM HARVEY

day a small personal electronic device (PED) such as a laptop, mobile phone, CD player or games computer is going to cause as much carnage on an aircraft as a terrorist's bomb.

Tiny electronic signals from these devices can be picked up by a plane's automatic navigation systems, sending them haywire.

The personal devices, like most modern electrical equipment, operate on a binary system which sees small electric currents switching at incredibly fast rates through the system.

The switch goes on if it receives a message of between two to five volts or stops if it gets nothing.

In modern computers this switching process occurs at a rate of hundreds of millions a second and creates electro-magnetic radiation in its immediate area.

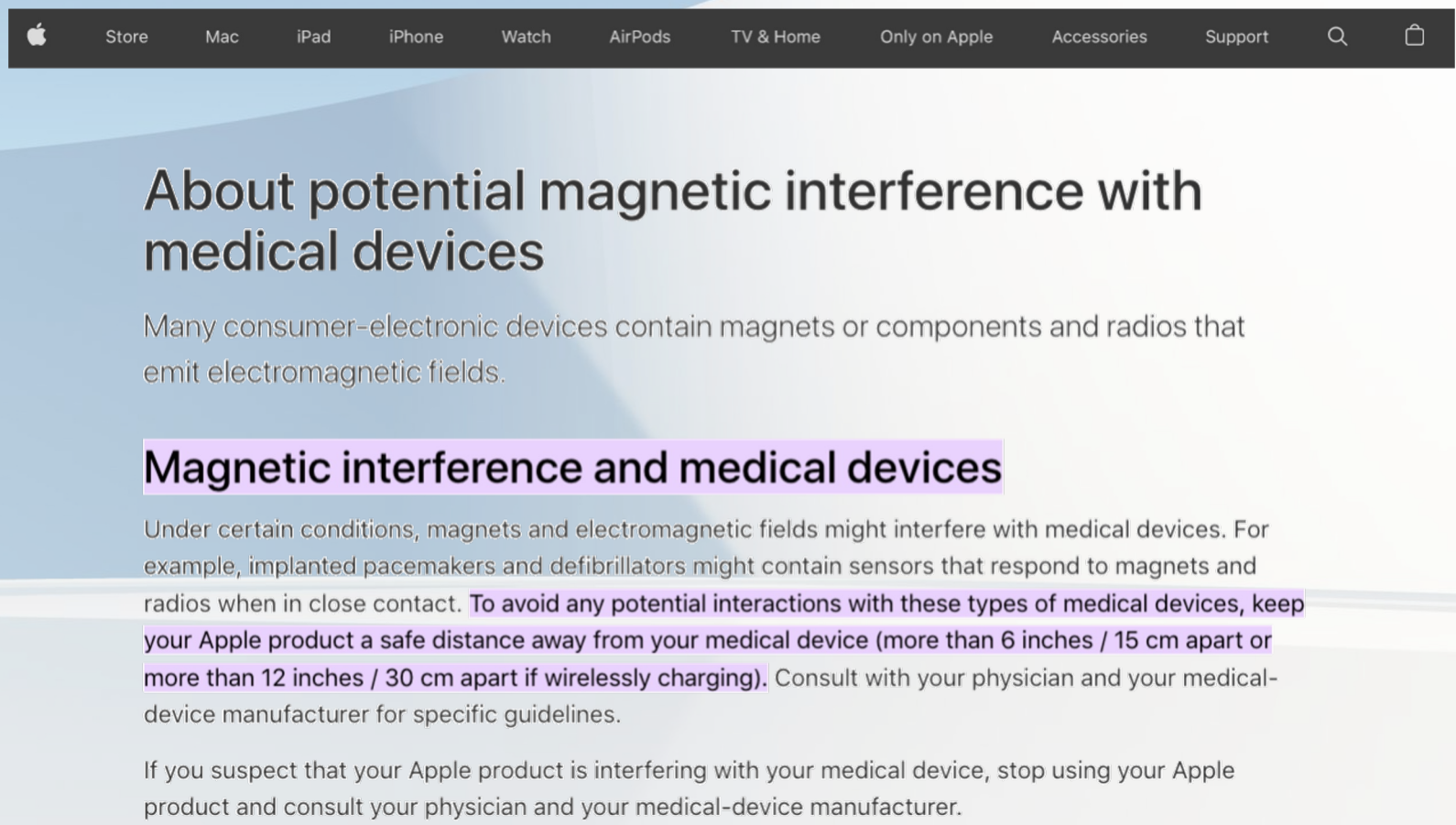
A mobile phone communicates by electro-

Page 42 The Sunday Mail October 4, 1998

INTRODUCTION: OVERVIEW

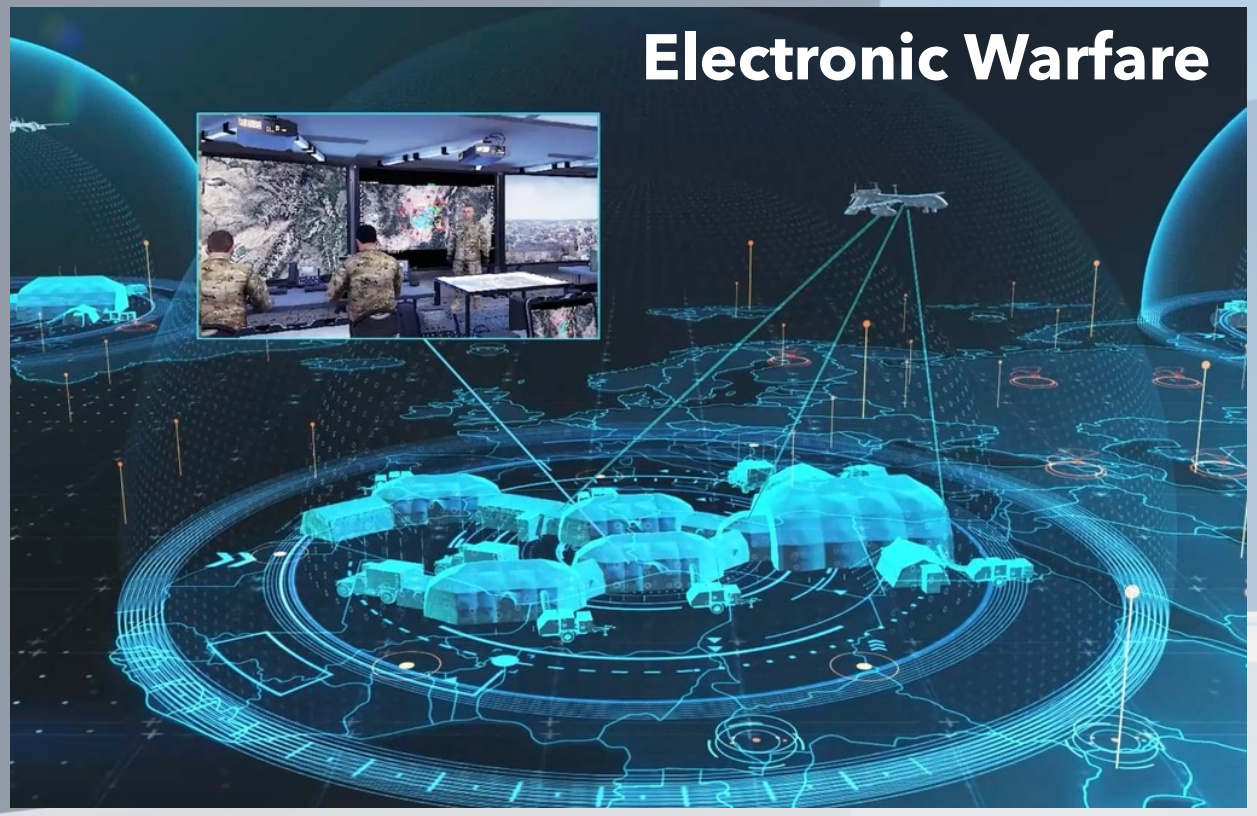
EMCS: Stories of failure

2023



INTRODUCTION: OVERVIEW

EMCS: Stories of failure



- **Tsushima battle, Russia vs Japan war (1905)**

- **WWII: Battle of beams (W. Churchill, 1940)**

INTRODUCTION: OVERVIEW

EMCS: Stories of failure

Jamming

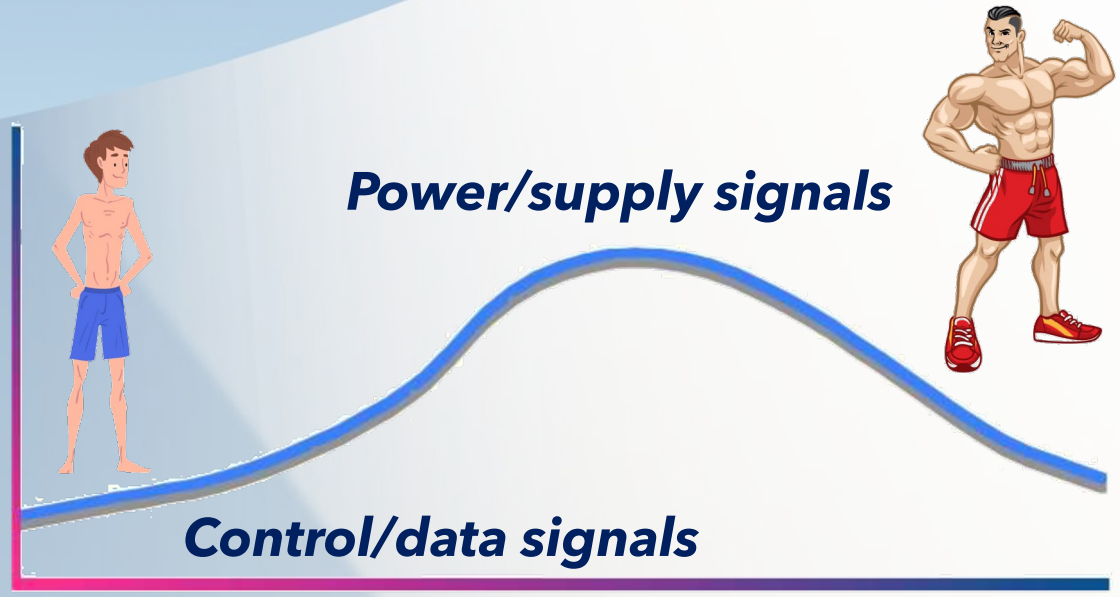
Side-channel EM attacks

INTRODUCTION: OVERVIEW

EMCS: Environments

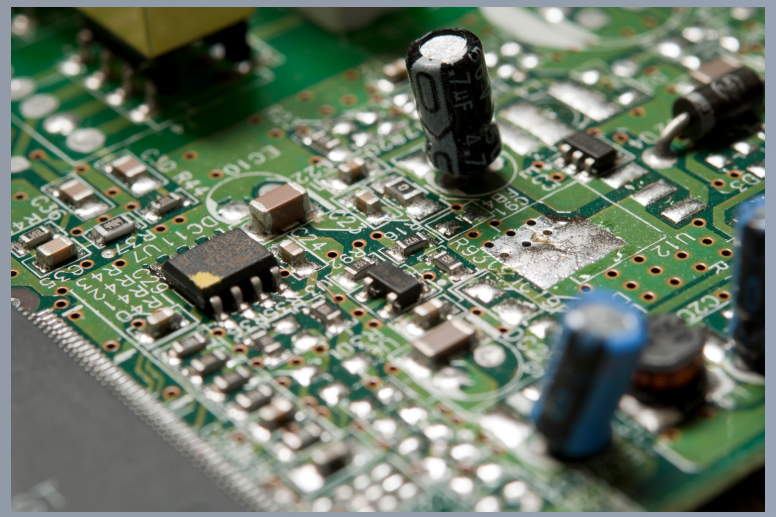
INTRODUCTION: OVERVIEW

Why EMCS?

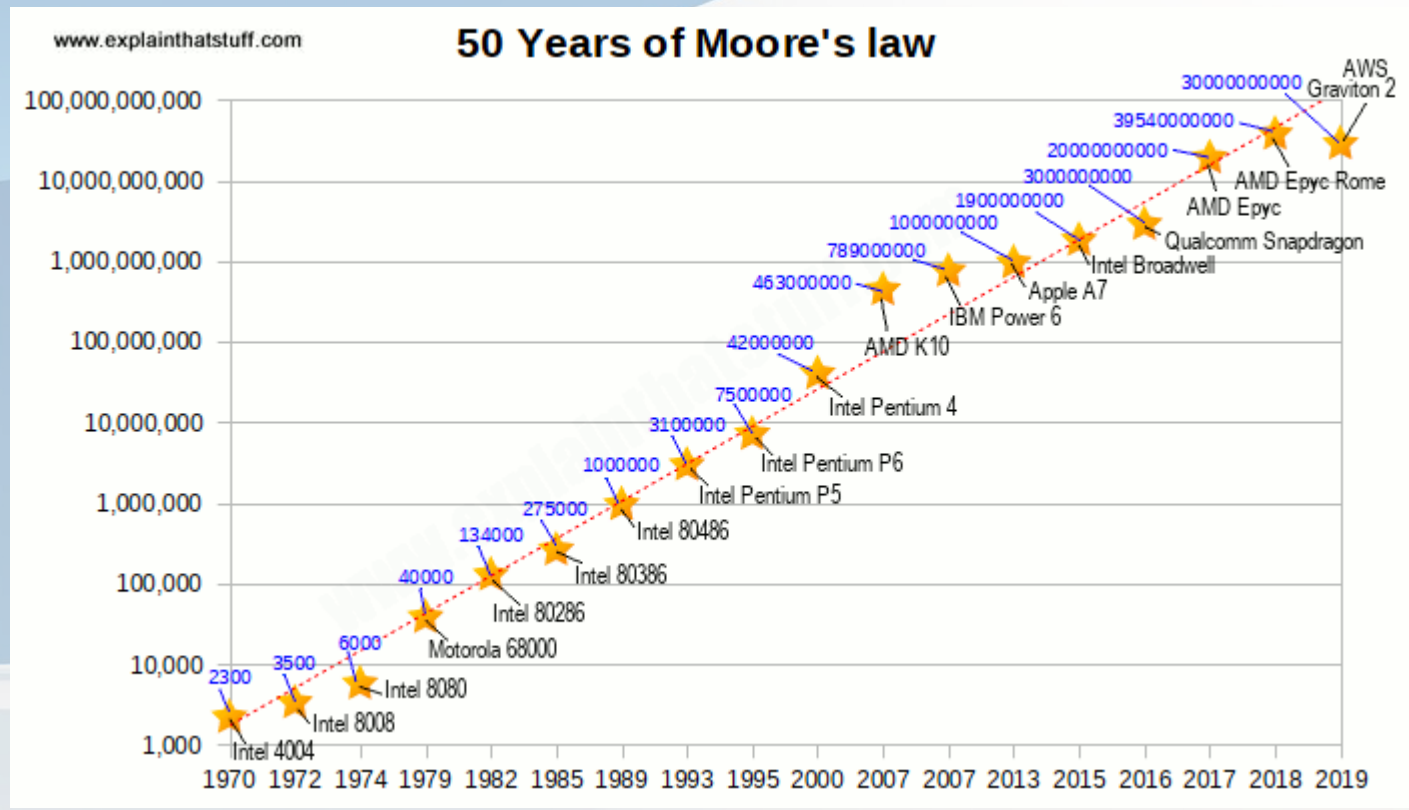


INTRODUCTION: OVERVIEW

Why EMCS?

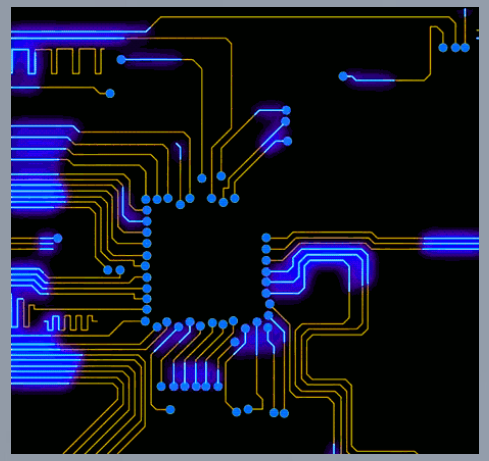


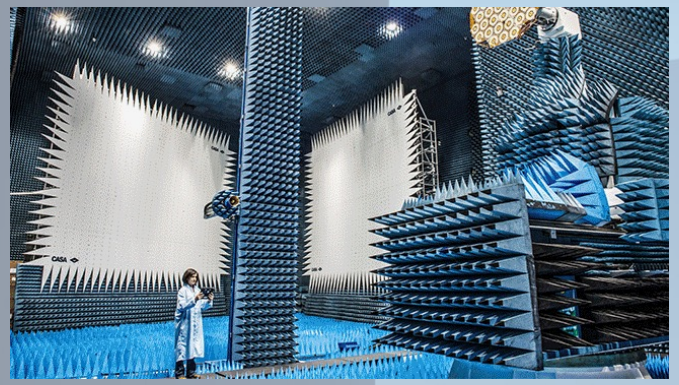
- **Weaker signals**
- **VLSI and ULSI circuits**
- **Reduced shielding capabilities**

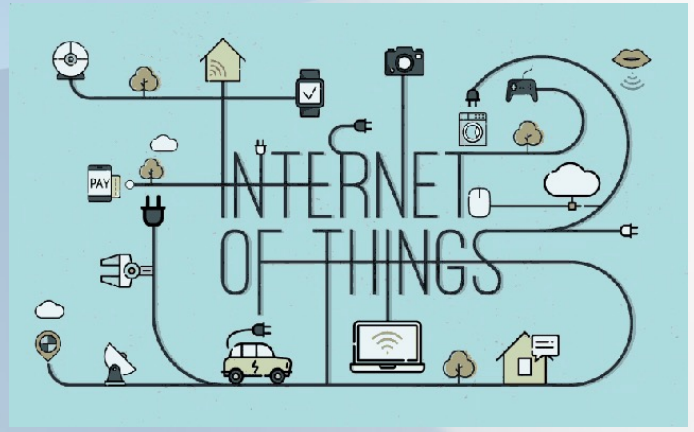


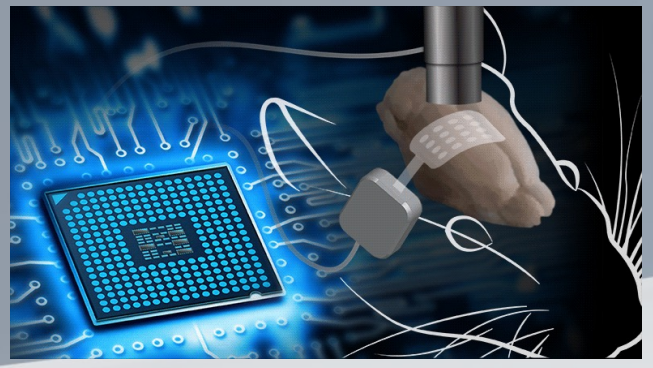
INTRODUCTION: OVERVIEW

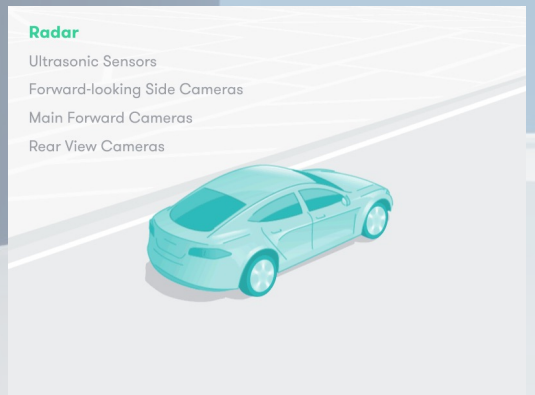
EMCS: Frameworks

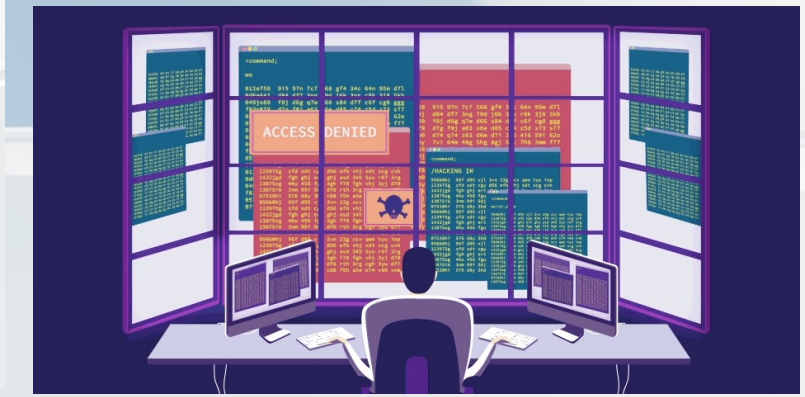












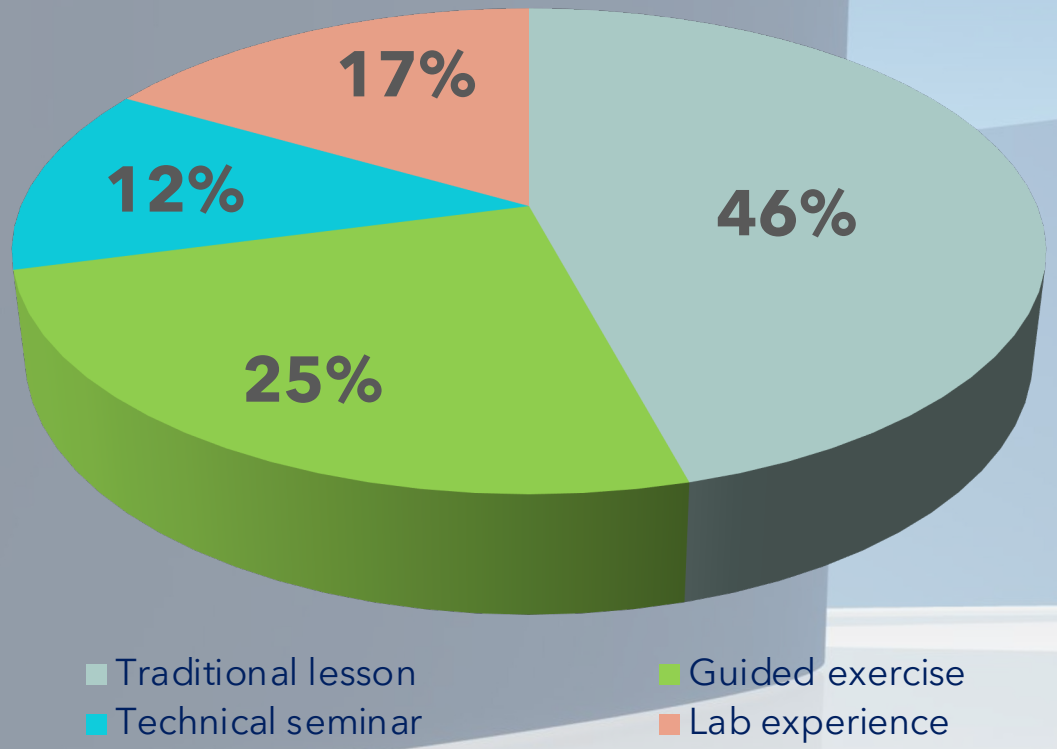
INTRODUCTION: ORGANIZATION

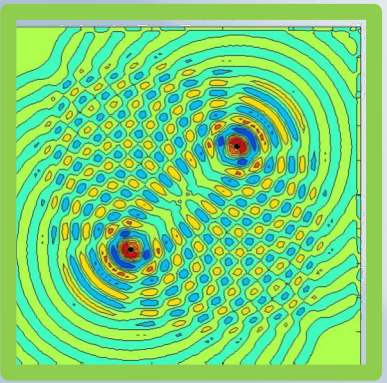
Main topics:

- ✓ Basics of EMC
- ✓ Frequency domain analysis
- ✓ Circuit models
- ✓ Radiated emissions and immunity
- ✓ Conducted emissions and immunity
- ✓ Crosstalk
- ✓ Filtering and shielding
- ✓ EMC measurement facilities
- ✓ EMI reduction methods
- ✓ Information leakage and EM security
- ✓ Human exposure to EM radiations
- ✓ Regulations and measurement standards

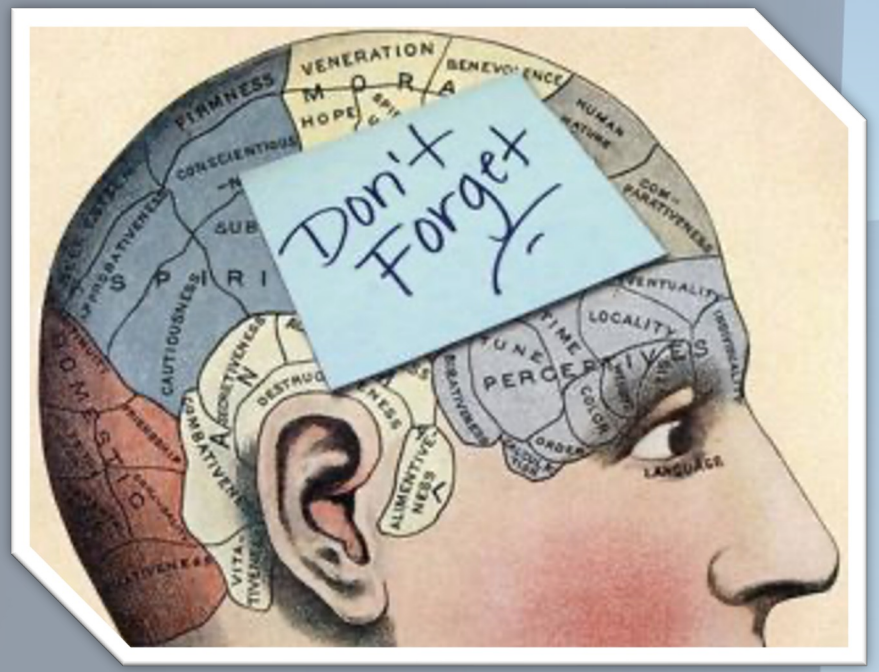
INTRODUCTION: ORGANIZATION

6 CFU – 48 hours





INTRODUCTION: ORGANIZATION



The following background is needed:

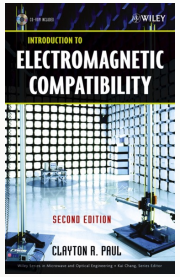
- **EM fields**
- **Antennas and propagation**
- **Circuit theory**
- **Digital and analog electronics**
- **Signal theory**
- **Analysis in the frequency domain**

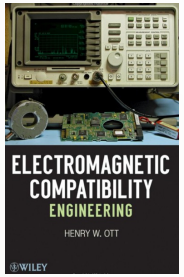
INTRODUCTION: ORGANIZATION

- **Timetable: Monday, room 9, 16:18**
  Thursday, computer room 3, 14:16

- **Material: Slides (e-learning)**
  Suggested textbooks

moodle



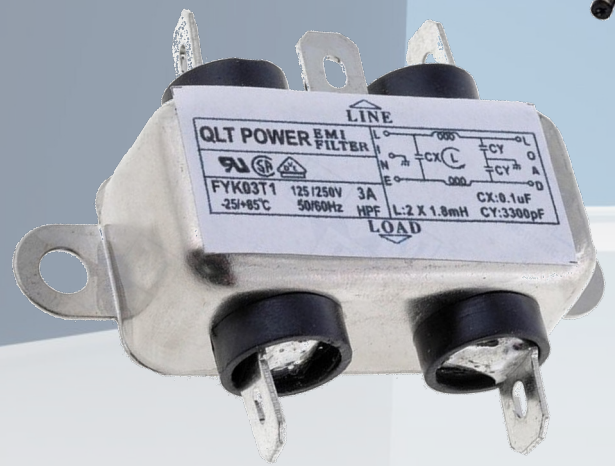


- **Contacts: andrea.buono@uniparthenope.it**
  MS teams

- **Exam: Oral interview**

INTRODUCTION: ORGANIZATION

At the end of the course....



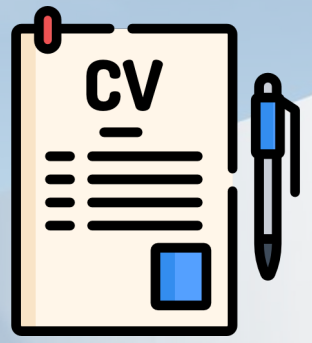
INTRODUCTION: ORGANIZATION

At the end of the course….

- Automotive
- Aerospace
- Bioengineering
- Embedded systems
- Media
- Security
- Sensor networks
- TLC
- …….

INTRODUCTION: AUDIENCE

Introduce yourself

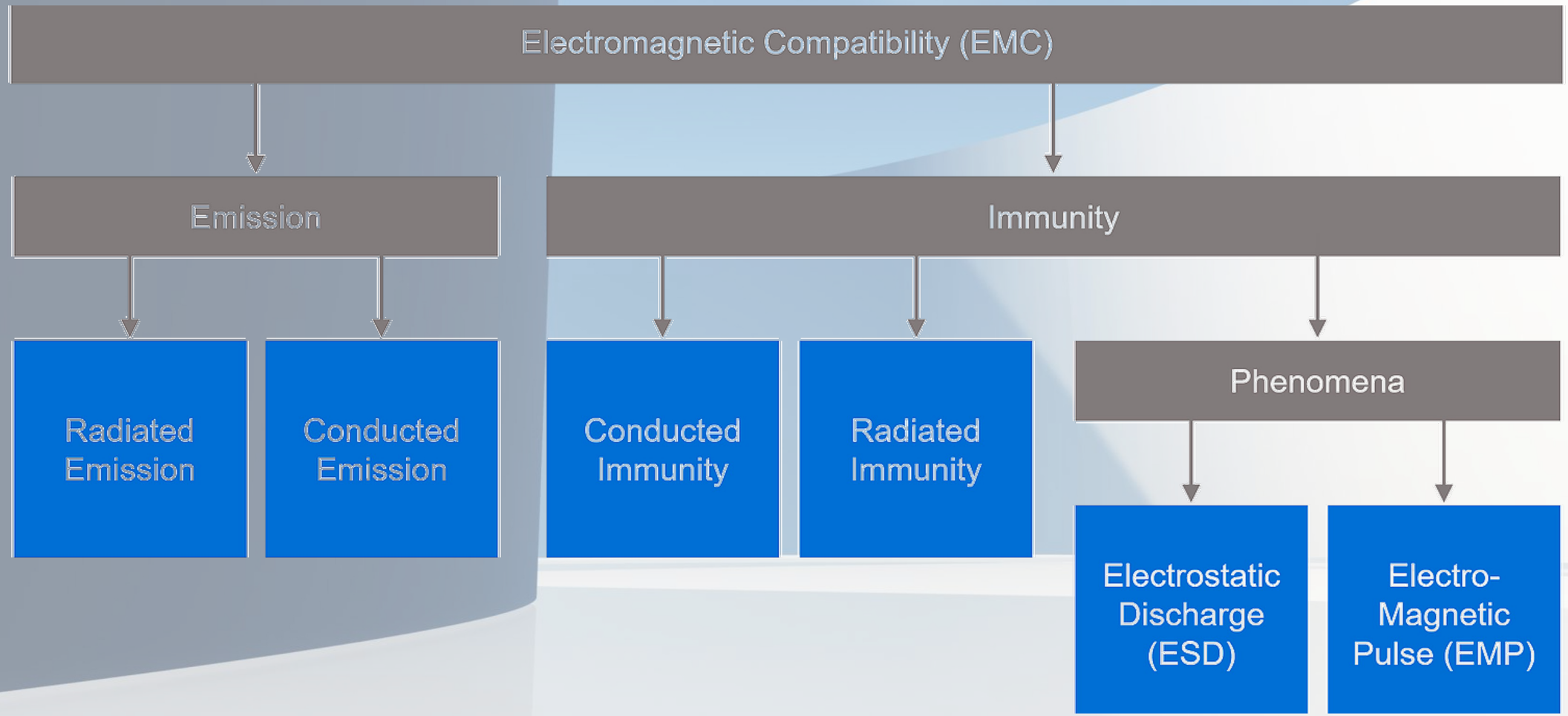


ISDC

ITICS

CHOOSE

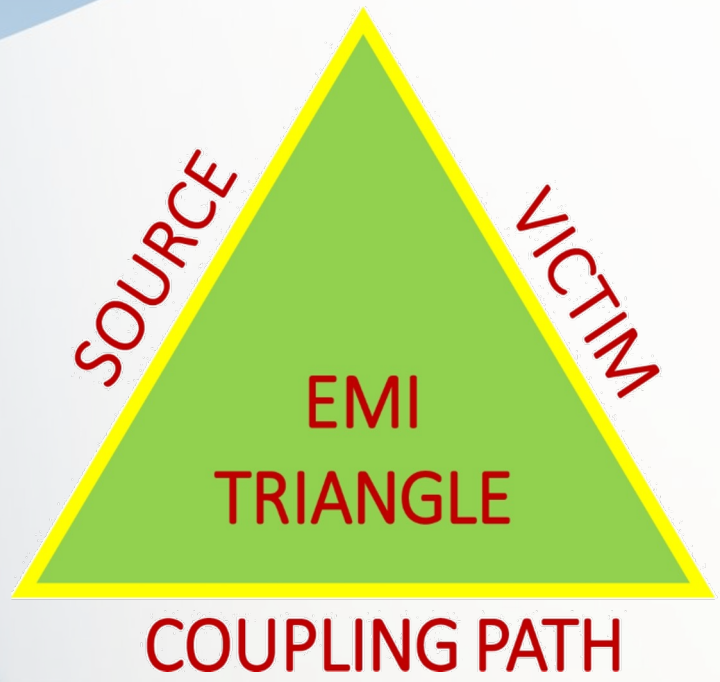
INTRODUCTION: BASICS



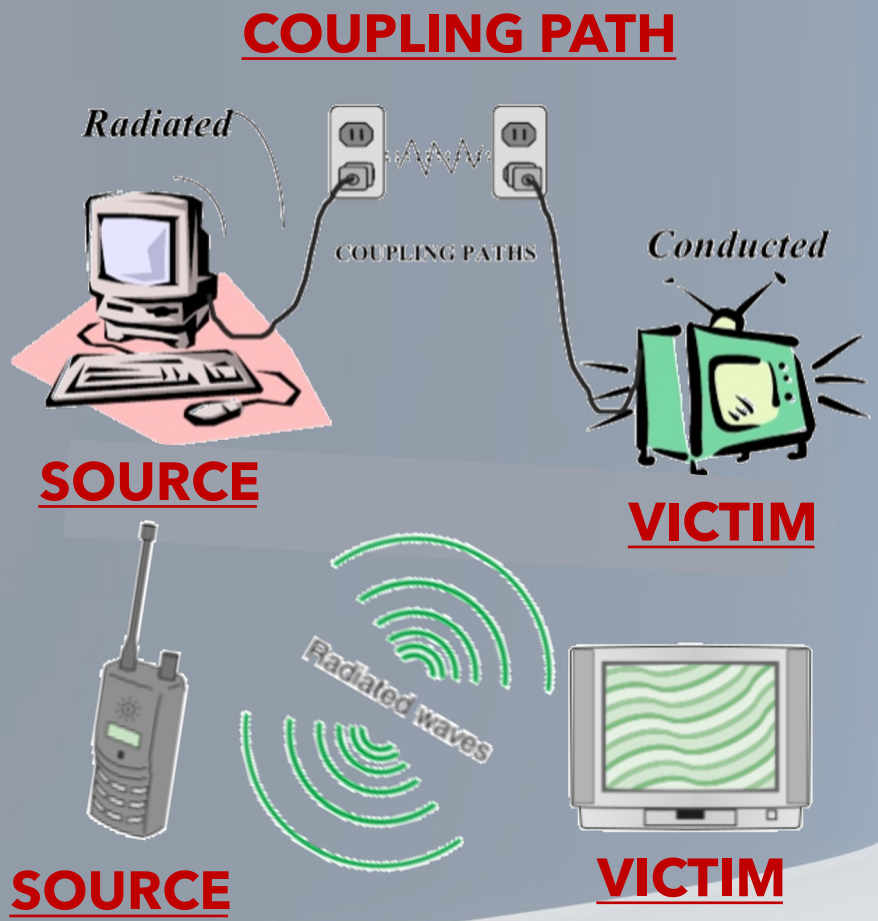
INTRODUCTION: BASICS

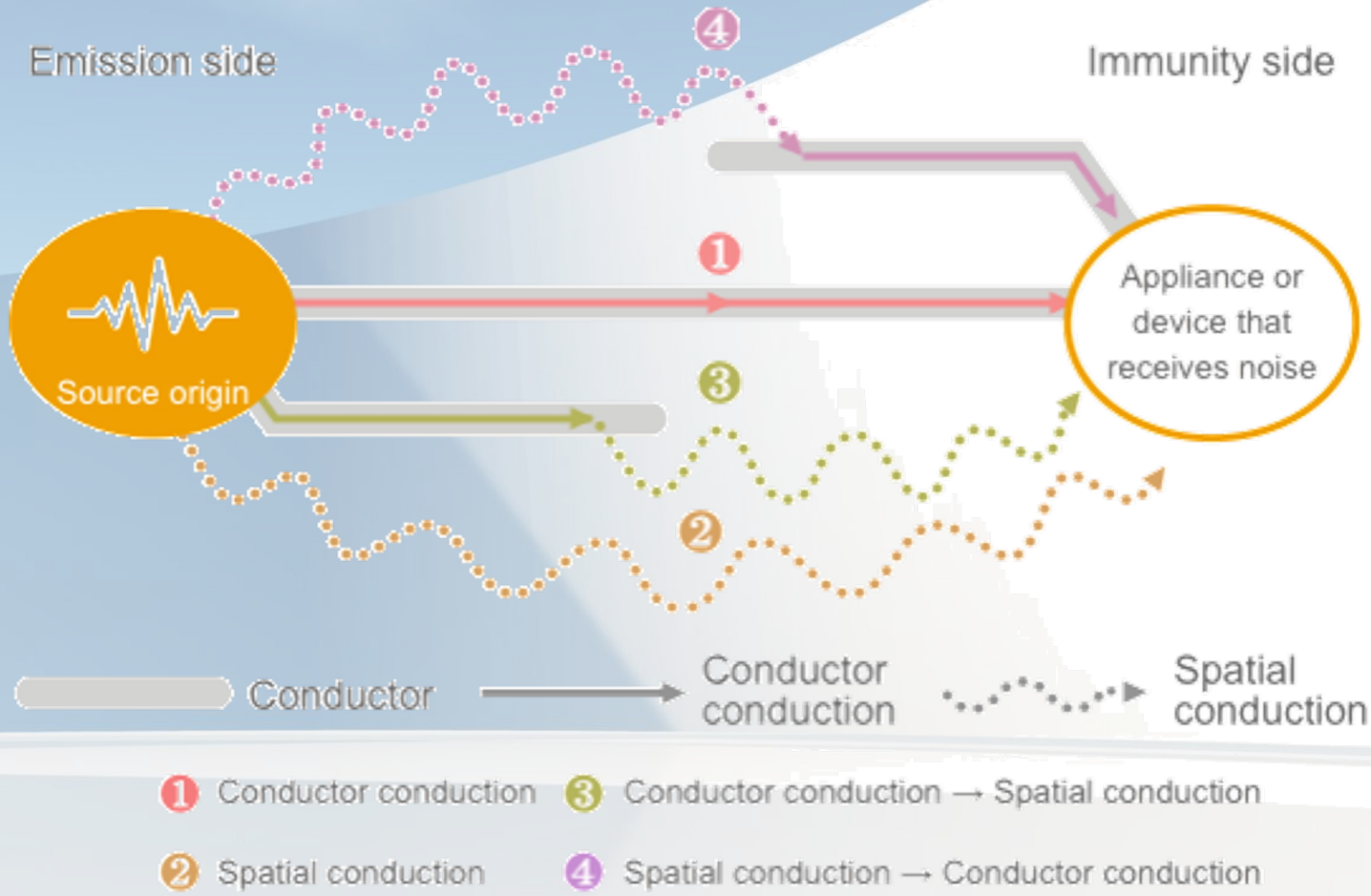
Electromagnetic Compatibility (EMC)
The discipline that aims at ensuring that all the electronic components/subsystems regularly work together in any electromagnetic environment

Electromagnetic Interference (EMI):
Undesired interaction among components/subsystems under their standard working conditions due to the propagation of electromagnetic energy

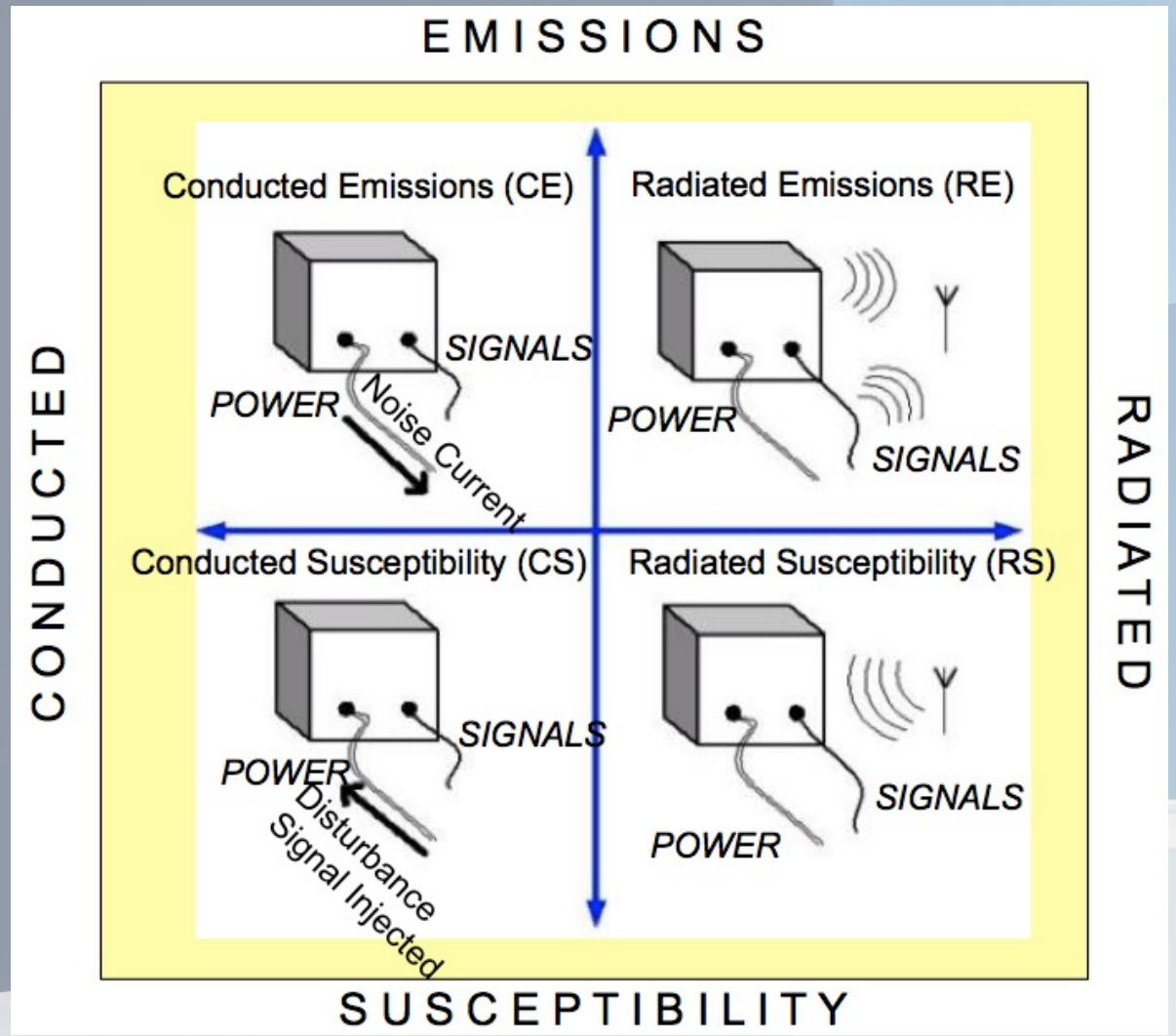


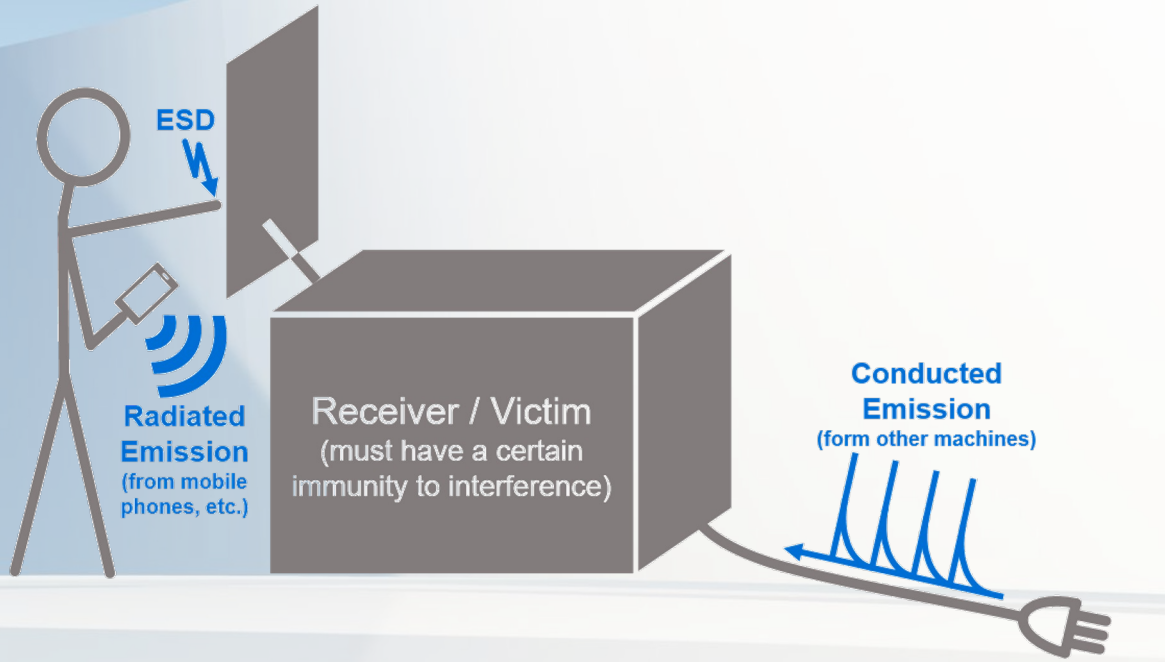
INTRODUCTION: BASICS





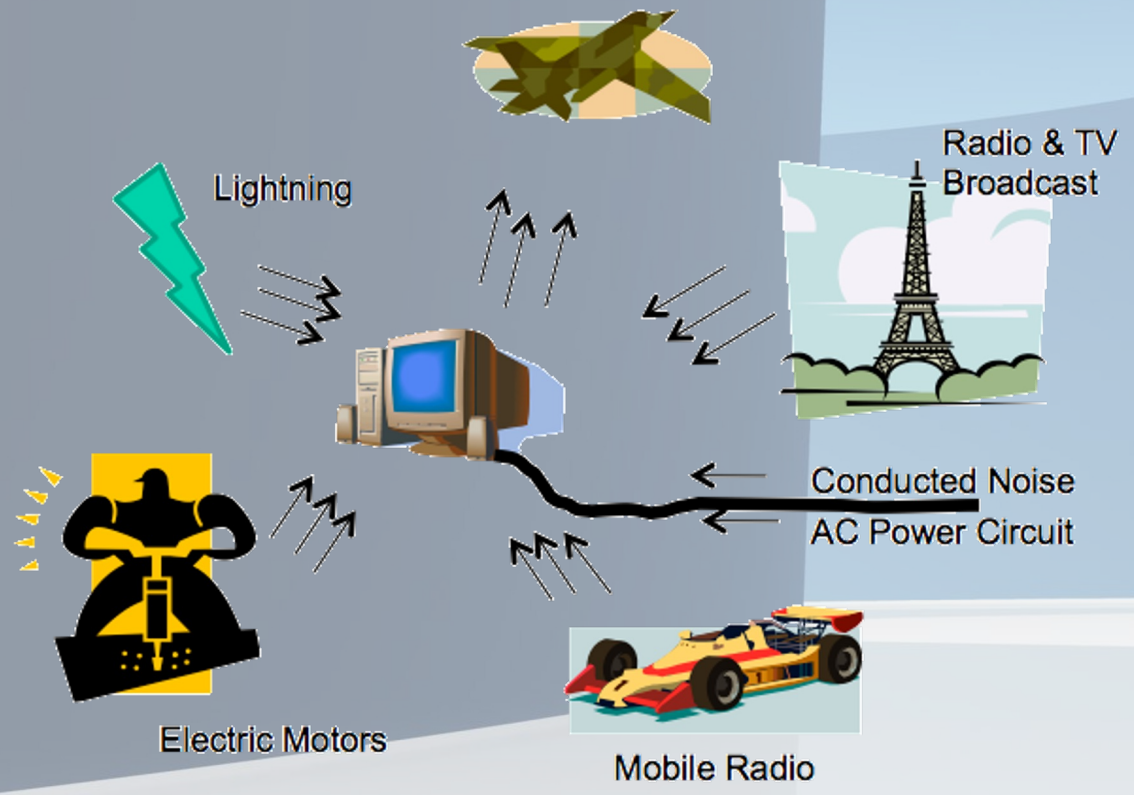
INTRODUCTION: BASICS

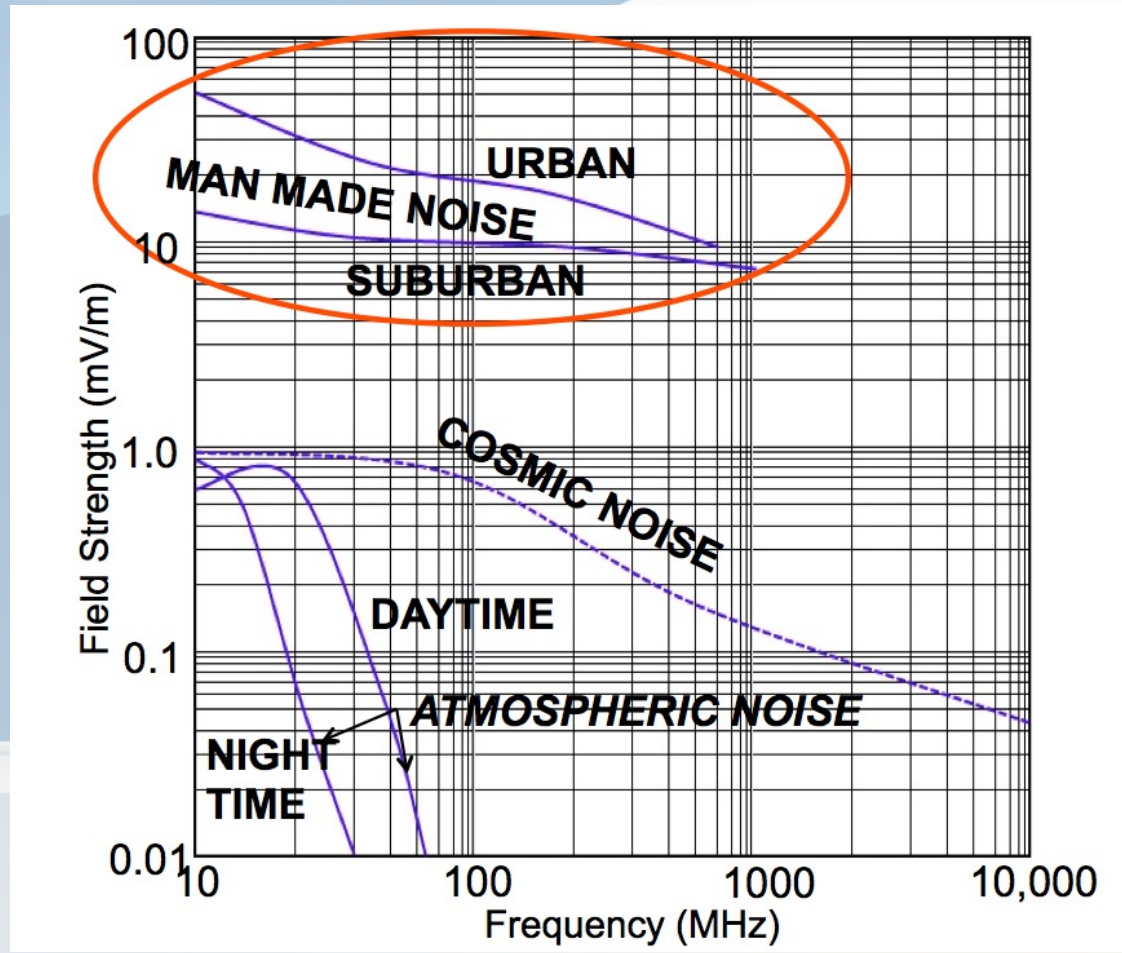




INTRODUCTION: BASICS

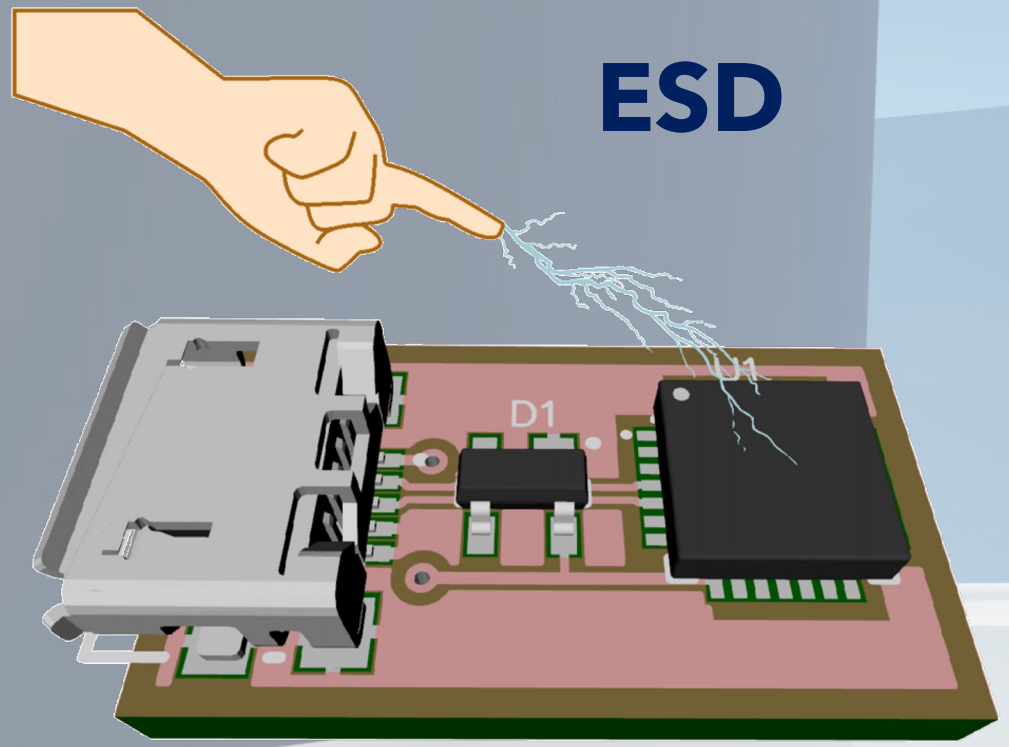
Man-made and natural processes:



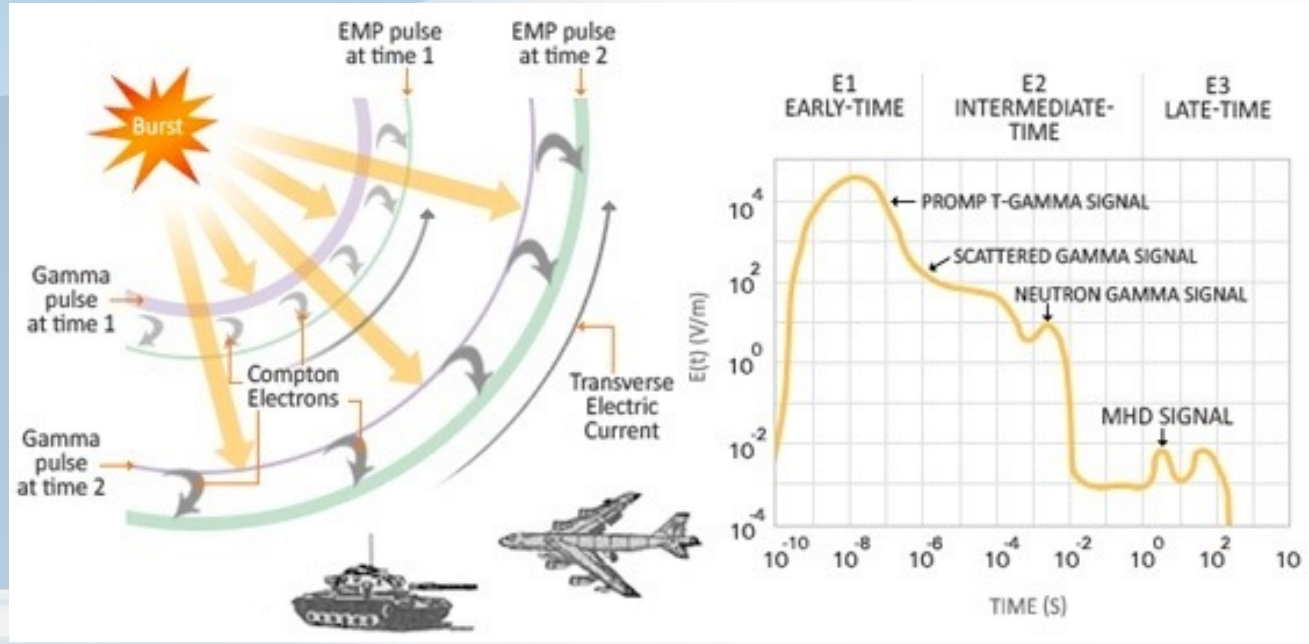


INTRODUCTION: BASICS

Further processes:



ESD



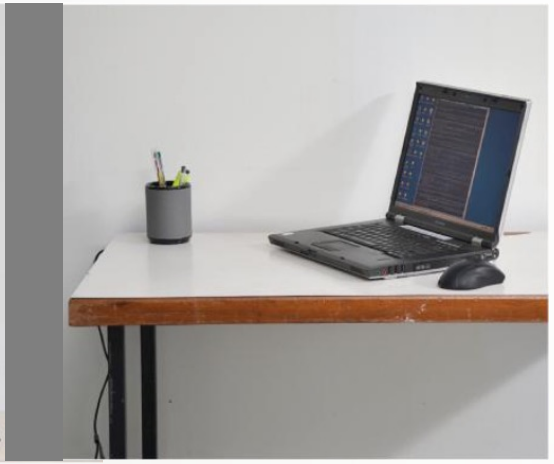
EMP

INTRODUCTION: BASICS

Further processes:

LIGHTNING

INFORMATION LEAKAGE



INTRODUCTION: BASICS

Standards and regulations

MODELS

Power supplies
EM attacks
Crosstalk
Radiated emissions
Coupling mechanisms
Circuit passive components
Radiated immunity
Electrostatic discharge

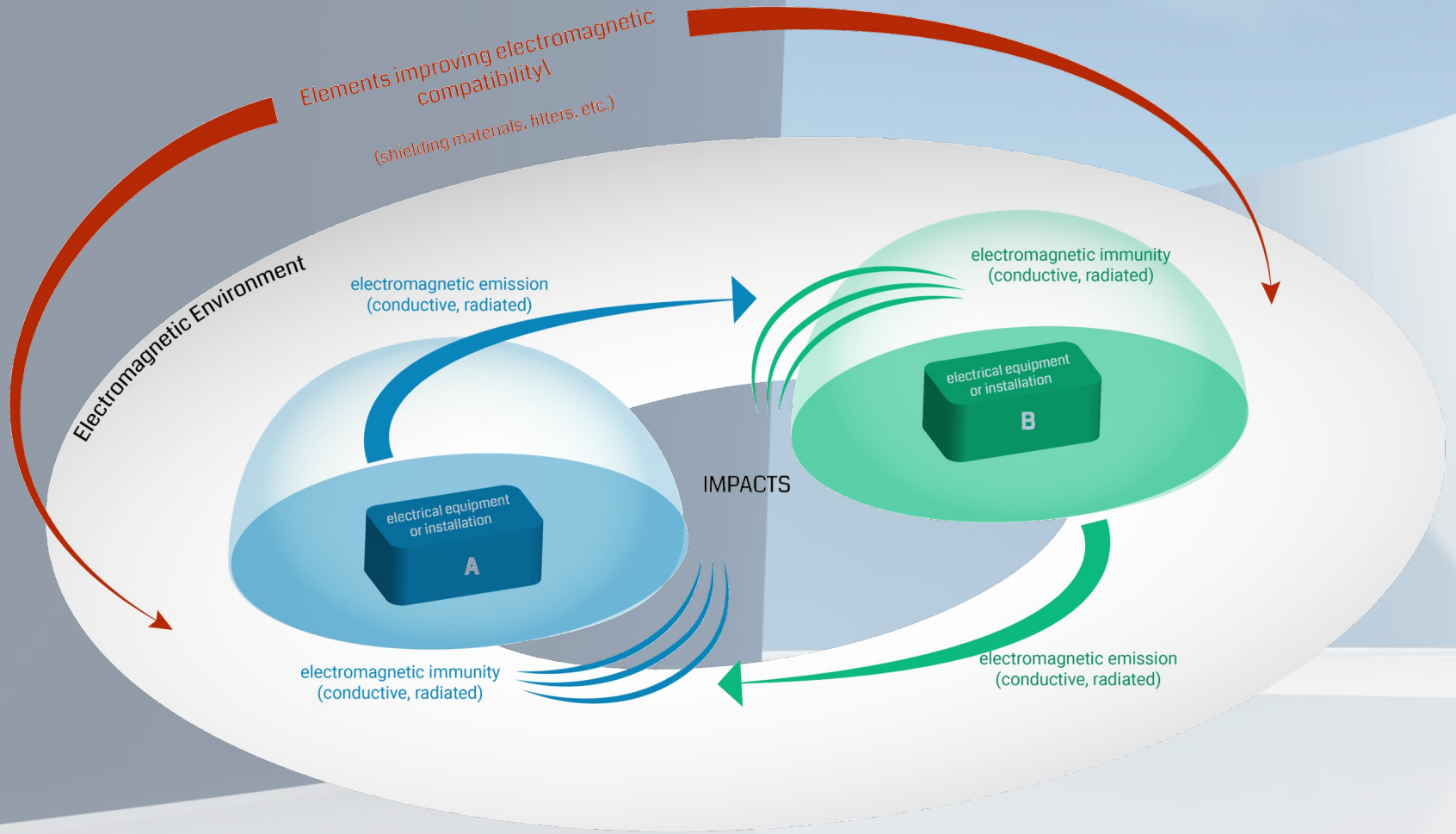
MEASUREMENTS

EMC facilities
Spectrum analyzer
Dosimetry
Shielding effectiveness
Line impedance stabilization network
Current probes
Specific absorption rate

REMEDIATIONS

Ferrite beads
Chokes
Shielded wires
Power supply filters
EMC-driven smart planning
EM shields

INTRODUCTION: BASICS

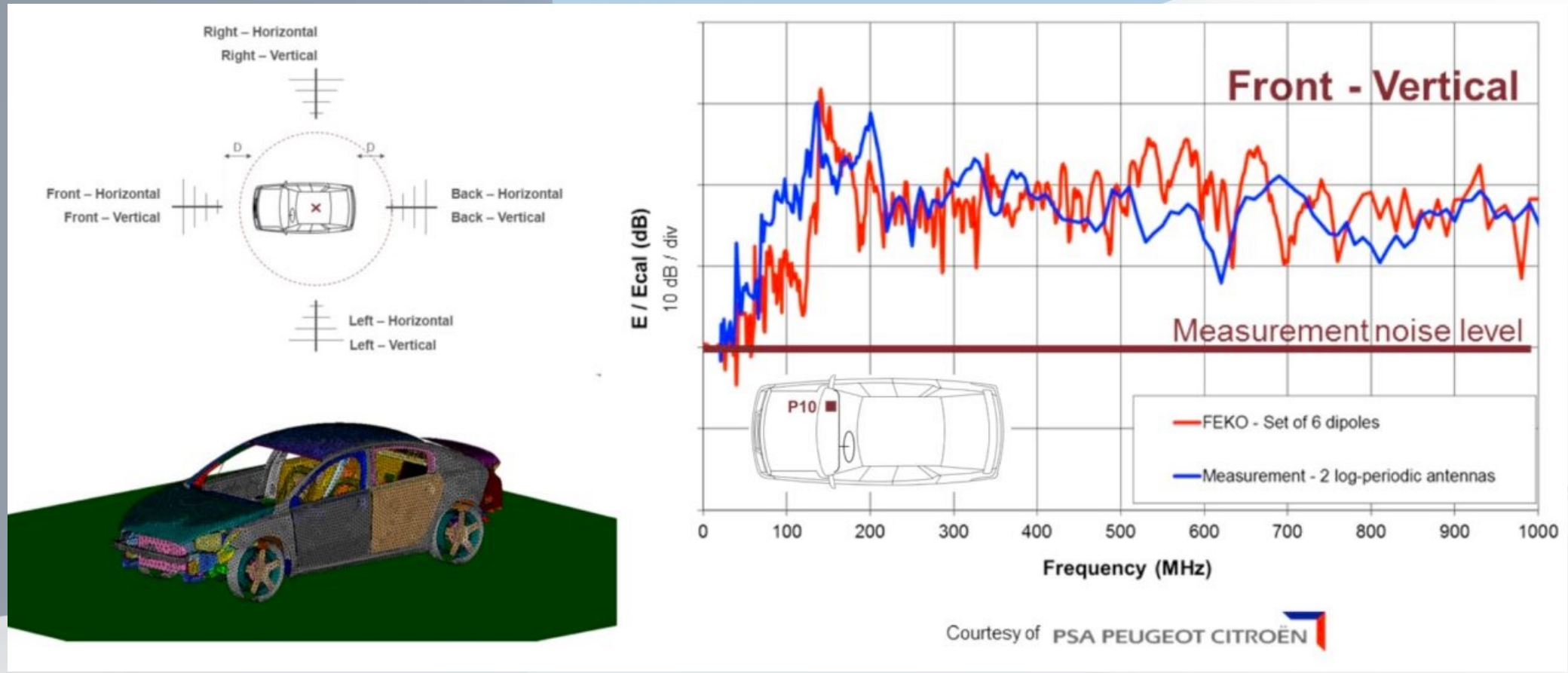


STANDARDS & REGULATIONS

- ***MODELS***
- ***MEASUREMENTS***
- ***REMEDIATIONS***

INTRODUCTION: BASICS

Showcase: AUTOMOTIVE



INTRODUCTION: BASICS

Showcase: EM INFORMATION SECURITY

INTRODUCTION: BASICS

Showcase: TLC

Report No: CCIS13070022502

6.2.2 Conducted Emission

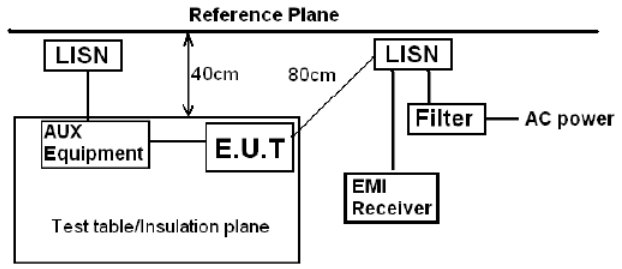
Test Requirement:	ETSI EN 301 489-3
Test Method:	ETSI EN 301 489-1
Test Frequency Range:	150kHz to 30MHz
Class / Severity:	Class B
Receiver setup:	RBW=9KHz, VBW=30KHz

Limit:

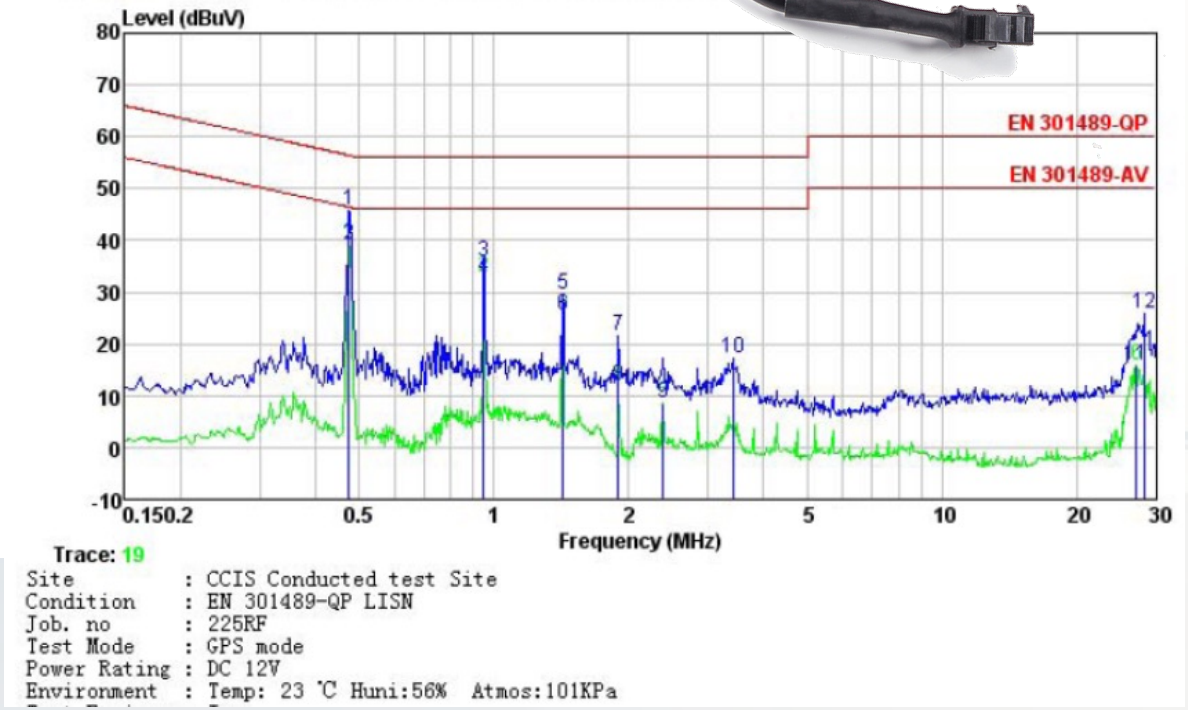
Frequency range (MHz)	Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency.

Test setup:



Remark:
E.U.T: Equipment Under Test
LISN: Line Impedance Stabilization Network
Test table height=0.8m



INTRODUCTION: BASICS

Showcase: Human exposure